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Plant Diseases in 1911

Potato Spraying Experiments in 1911

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BULLETIN 162: PLANT DISEASES IN 1911
POTATO SPRAYING EXPERIMENTS IN 1911

By B. F. Lutman

PLANT DISEASES IN 1911

The summer of 1911 was remarkable for its very high temperature and scanty rainfall, especially during July and the first half of August. As a consequence of these meteorological conditions, plant diseases were rare. Those epidemic diseases such as brown rot of plums, orange leaf rust of the blackberry and the mildews, which spread as a result of high humidity, were checked early in the summer and in many cases it was rather difficult to find specimens. The grain rusts, also, seemed to be much less abundant than usual.

The early and late blights of the potato plant were not reported during the summer and no cases were observed. Tip-burn, resulting from the very hot, dry weather, was disastrous on light sandy soils around Burlington. By August 5, those plants that had not been sprayed had lost in many instances at least two-thirds of their leaf surface. Tip-burn appeared from ten days to two weeks earlier than usual on account of the unusual conditions. The rains of August 15 and 18 revived the plants somewhat, but they never recovered from the drought of the earlier part of the season. The weather chart of the three months of July, August and September, 1911, shown on page 40, clearly brings out the very high temperature of July and August and the scanty precipitation from July 7 to August 15.

An attempt was made to ascertain the percentage of oat smut likely to be found nowadays in Vermont oat fields. Judging from the appearance of the fields around Burlington it was thought that the percentage would be found to be rather high. Reports from six widely separated regions were made by students of the College of Agriculture. Actual counts were made in fields by the barrel hoop method. The amount of smut has apparently not increased since 1892 and 1893 when it was estimated to be from 1 to 3 percent.[1] The fact that home grown seed is largely used in Vermont is doubtless responsible for this gratifying sit-

[1] Vt. Sta. Rpts. 6, pp. 73-82 (1892); 7, pp. 60-65 (1893).

uation. Indeed, it was noted that where western or foreign seed was sown the percentage of smutted heads was higher. Treatment of the seed for oat smut is not worth what it costs when the proportion of smut is so low.

An interesting apple disease appeared on Baldwins and Greenings and was often reported. The affected fruit showed sunken spots over the surface of a darker hue than that of the surrounding skin, that is to say of a darker red or a darker green, depending on the location of the spot, which, however, were never brown. In most cases these spots extended only a few cell layers below the epidermis and were of a dry and corky nature. Apparently these spots were the true "stippenflecken" described by the German stations[1], being quite different from the Baldwin fruit spot as described by Brooks.[2] Specimens were also received wherein corky dry streaks extended from the surface to the core following in general the vascular system. These are more nearly similar to those described by Jones[3], in 1898. The extreme dry weather of July and August, the period of growth of the fruit, doubtless induced these physiological diseases. It has been found in Germany that these "stippenflecken" of apples are more numerous in very dry seasons.

POTATO SPRAYING IN 1911

The potato spraying experiments of 1911 were a continuation of work on the physiological effect of bordeaux mixture on the sprayed plants. As has been noted a number of times in earlier bulletins[4], bordeaux mixture appears to serve two purposes, namely: (1) As a fungicide, preventing early and late blights, (2) As a stimulant to the plant, causing it to produce a larger amount of starch. The first of these effects is well recognized and has been proved beyond question. The second effect, how-

[1] Wortmann, Ueber die sogennante, "Stippen" des Aepfel. Landw. Jahrb. 21, pp. 663-675 (1892). Bschokke, Landw. Jahrb. d. Schweiz. 11, p. 192 (1897).

[2] N. H. Sta. Rpts. 19 and 20, pp. 332-386 (1907-1908).

[3] Vt. Sta. Rpt. 12, pp. 159-164 (1898).

[4] Vt. Sta. Bul. 159 (1911) and others preceding it.

ever, is less clearly determined. The experiments herein cited attempt to throw light on some of the obscure points as to bordeaux stimulation.

Under the conditions of potato growth around Burlington —and the same results have been obtained at a number of other places, notably in New York—there seems to be no question that sprayed potato plants yield more tubers than do unsprayed plants even in years when no fungus diseases occur. It has not been definitely ascertained, however, whether this is due to:

1. A daily increase in the amount of starch produced within the sprayed plants on account of the application of the copper mixture; or

2. An increase in amount of starch brought about by the lengthened life of the plant during September; unbordeauxed plants dying ten days to two weeks earlier as a rule than unsprayed ones.

The same problem was under survey last year[1]; and the work of the current year has been in the main an attempt to repeat and to verify the results then secured. The method used to determine whether an actual daily increase resulted from the application of bordeaux mixture to the foliage was to dig the potatoes at various times during the summer and early fall and weigh the tubers from bordeauxed and unbordeauxed rows. Last year's results indicated that the bordeauxed plants stored daily more starch than did those not thus treated. The first harvest (September 2) yielded 194.8 bushels per acre from the sprayed plots and 170 bushels from the unsprayed; the second (September 16), 299.8 bushels from the sprayed area and 210.8 bushels from the control; the final harvest (October 20) showed 240.3 bushels per acre from the sprayed plants and only 202.1 bushels from the unsprayed. At the time when each harvest was made the sprayed plants had produced more pounds of starch and more bushels of potatoes per acre than had the unsprayed plants, regardless of the lengthened life of the plants themselves.

[1] Vt. Sta. Bul. 159 (1911).

Copper compounds other than the usual bordeaux mixture were also used on some of the plots. These mixtures were a bordeaux in which part of the copper sulphate was replaced by iron sulphate, Pickering's bordeaux mixture, Cucasa, and a soap-silver nitrate solution.

The copper-iron sulphate mixture contained 4 pounds iron sulphate, 2 pounds copper sulphate, 6 pounds lime and 50 gallons of water. This had been applied during the two preceding years and found almost to equal bordeaux in its effect on the plants. It was thought that this season might give an opportunity for testing its physiological effects in addition to its fungicidal properties.

Pickering's bordeaux mixture is a compound recommended by the Woburn (England) Experiment Fruit Farm[1]. It consists of the precipitate formed by the addition of a weak copper sulphate solution to a saturated solution of lime-water. The advantages claimed for it are: (1) It is immediately fungicidal, whereas ordinary bordeaux requires some days before it is effective. (2) It does not clog the spray nozzles. (3) It does not scorch foliage as easily as do those mixtures made from the milk of lime. Pickering's bordeaux was used on the present experiment because it practically eliminated the question of lime and of shading. Some investigators have claimed that the effects are due in the ordinary mixture to the lime rather than to the copper, while others believe that bordeaux shades the leaves enough to make a difference between the treated and untreated plants.

"Cucasa" is a copper saccharate spray mixture put up in cartons by the Dr. L. C. Marquart Chemical Works, at Beul on the Rhine, Germany. Each carton contained two packages, a blue and a white one. The blue package, which weighs about 2½ pounds (1130 grams), contains, according to the analysis

[1] Woburn Exp. Fruit Farm Rpt. 116 (1910).

of an Austrian experiment station[1], 51.6 percent of copper sulphate and 41 percent of cane sugar. The white package, which weighs about a pound (420 grams) contains, according to the same analysis, 83.2 percent calcium hydroxide and 16 percent calcium oxide. The blue package is dissolved in about ten gallons of water and the white package is then stirred in. The result is a blue precipitate which, after a few minutes stirring, goes into solution, forming a dark blue liquid. It is claimed by the inventor that this dark blue liquid (a copper saccharate) is much more efficacious in the prevention of disease than is bordeaux prepared in the ordinary way. It was, however, with the intention of ascertaining its effect on the sprayed plants rather than its fungicidal properties that one plot was treated with this mixture. It presents the advantage of containing no free lime and of producing a minimum of shading, while getting the copper on the plant.

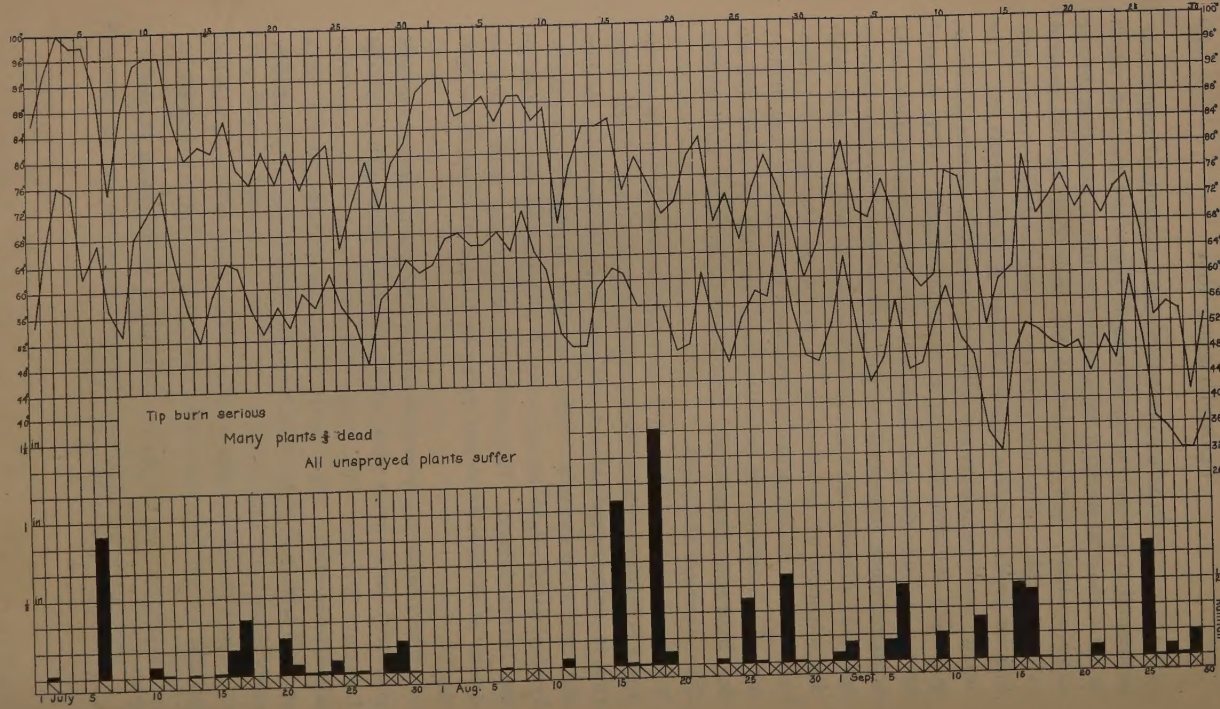
Vermorel and Dantony[2] have recommended a mixture of silver nitrate and soap for spraying grape vines. They claim that it produces the same dark green color in the leaves as does the copper compounds. This naturally suggested that an increased yield might be expected if a similar effect resulted on the potato foliage. The compound was made with about 15 grains of silver nitrate and 75 to 85 grains of soap to the gallon.

The ordinary 5-5-50 bordeaux mixture was used. One half pound of paris green was added to every fifty gallons of the bordeaux mixture, Pickering's bordeaux and the copper-iron sulphate mixture. The control plants and those on the plots sprayed with the other mixtures were dusted regularly with dry paris green and lime (1:20).

The Green Mountain potatoes which were used were planted on May 15, and sprayings were made July 13, July 31, August 12

[1] Zeitschrift für das landwirtschaftliche versuchwesen in Oesterreich (1910).

[2] Prof. Agr. et Vit (Ed. l'Est. Centre) 31, No. 32, pp. 168, 169 (1910); Abstr. in Exp. Sta. Rcd. 24, p. 51 (1911).


Tip burn serious
Many plants dead
All unsprayed plants suffer
Year 1911
Rainfall
1 July
1 Aug.
1 Sept.

and August 24. The season was an excellent one for conducting experiments on the effect of the spray mixtures on the treated plants in view of the fact that no potato diseases appeared to introduce disturbing factors. Tip-burn, especially on the unsprayed plants, was very common after the 5th of August.

The first digging was made August 30. It consisted of a plot on which the plants had been sprayed with 5-5-50 bordeaux mixture and a control plot.

	Marketable tubers per acre	Small tubers per acre	Total tubers per acre
Sprayed with bordeaux mixture.....	41.1 bu.	12.5 bu.	53.6 bu.
Control	22.7 "	7.8 "	30.5 "

At this time the unsprayed plants had already suffered badly from the tip-burn and the tops only weighed a half pound each as compared to one pound and seven ounces for the sprayed.

The second digging was made September 13 when a sprayed plot and an unsprayed one were dug with the following results:

	Marketable tubers per acre	Small tubers per acre	Total tubers per acre
Sprayed with bordeaux mixture.....	85.3 bu.	10.7 bu.	97.0 bu.
Control	46.0 "	8.1 "	54.9 "

The rains of late August and the early part of September had checked the tip-burn and the weight of the tops was about the same as on September 13. The average weight of a sprayed top now was 1.21 pounds and of the unsprayed 0.52 pounds.

The third and final harvest was made on October 9, all the foliage being dead at this time. The yields from the various acre plots were as follows:

	Marketable tubers per acre	Small tubers per acre	Total tubers per acre
Sprayed with bordeaux mixture.....	144.2 bu.	12.7 bu.	156.9 bu.
Sprayed with iron and copper sulphate	113.3 "	10.8 "	124.1 "
Sprayed with Pickering's bordeaux..	109.9 "	9.1 "	119.0 "
Sprayed with Cucasa	139.7 "	10.8 "	146.5 "
Sprayed with silver nitrate and soap	58.4 "	11.4 "	69.8 "
Control	61.8 "	13.9 "	75.7 "

The year was an unfavorable one for potato development, especially on the light sandy soil which was used. This circumstance will account for the very light yields. No fungus or bacterial disease was present, and the results are without question due to the different spraying mixtures the plants received.

In every case where copper was used the plots showed an increase over the unsprayed plots, or those treated with silver-nitrate-soap mixture. The silver-nitrate-soap mixture in fact seemed to work slight injury. The plots sprayed with the mixture of iron and copper sulphate showed, as in previous years, that this compound is a close rival to the ordinary bordeaux. The yield from the "Cucasa" plot was almost as great as that afforded by the bordeauxed plants. The foliage treated with "Cucasa" did not show the marked dark-green color that is so characteristic of bordeauxed leaves, but the yield was consistently, row for row, larger than that from the check. The effect of the Pickering's bordeaux could also be seen in an increased yield, but it was not as marked an increase as from the 5-5-50 bordeaux. There is not nearly as much copper present in a gallon of this mixture as in any of the other mixtures applied. In fact, taking these figures at their face value, it would seem that the amount of increase is directly proportional to the amount of copper sulphate used. The surprising feature, however, was that the "Cucasa" should have afforded such a result without producing any marked change in the appearance of the foliage.

In general the results tend to confirm the deduction made as a result of last year's work, viz.: that the application of bordeaux mixture brings about a daily increase in the amount of starch produced per plant. This increase was much greater this year than last. Whether this increase would be as great on a heavy clay soil, or under the conditions of a large amount of rainfall, is a question still unanswered. From information received from one potato grower who sprays thor-

oughly, but whose land is much heavier than is the loose sandy soil around Burlington, it would seem that the results are not so well marked. On light soil, however, it pays to spray whether the year is a dry or wet one. If it is dry, the bordeaux prevents tip-burn with the resulting early death of the plants, and increases the amount of starch formed daily. If it is wet, the bordeaux effectually prevents the early and late blights with the resulting tuber rot induced by the latter malady.

A word might be added regarding the "Cucasa," the German mixture that produced such favorable results. The principal advantage it possesses is that it is convenient, because it is always ready. It can be bought in packages of various sizes and might be of service where only a small amount of spraying is to be done. The cost, however, prohibits its use in large field operations as the price, not delivered, is three times that of the materials of the ordinary mixture. A further disadvantage attending its use is that it will not keep any length of time.

The results attained at this station during twenty-one seasons' potato spraying are displayed on the next page. These may be best seen in the form of a table in which only the yields from the plots sprayed with bordeaux mixture are compared with control plots that have been left unsprayed.

GAINS FROM THE USE OF BORDEAUX MIXTURE ON LATE POTATOES

Planted	Sprayed	Yield per acre		Gain per acre		Prevalence of late blight
		Sprayed	Not sprayed			
White Star,		bu.	bu.	bu.	%	
May —, 1891	Aug. 26, Sept. 8,	313	248	65	26	some
May 20, 1892	Aug. 1, 16, 29,	291	99	192	194	much
May 20, 1893	Aug. 1, 16, 29,	338	114	224	196	much
Apr. 26, 1894	June 16, July 17, Aug. 30,	323	251	72	29	none
May 20, 1895	July 25, Aug. 13, 31,	389	219	170	78	rot
Polaris,						
May 15, 1896	Aug. 7, 21	325	267	68	26	none
June 1, 1897	July 27, Aug. 17, 28,	151	80	71	89	some
White Star,						
May 10, 1898	July 21, Aug. 10,	238	112	126	112	little
Average, 3 varieties,						
May 18, 1899	July 26, Aug. 17, Sept. 8,	229	161	68	42	little
Delaware,						
May 23, 1900	Aug. 4, 23,	285	225	60	27	rot
May 25, 1901	July 20, Aug. 21,	170	54	116	215	much
May 15, 1902	Aug. 1, 20,	298	164	134	82	severe
Green Mountain,						
May 1, 1903	Aug. 10,	361	237	124	52	severe
Delaware,						
May 25, 1904	Aug. 1, Sept. 1,	327	193	134	69	some
May 15, 1905	Aug. 2, 21,	382	221	161	73	severe
Green Mountain,						
May 27, 1906	Aug. 13, 22,	133	101	32	32	some
May 1, 1907	July 16, 25, Aug. 8, 22,	171	63	108	175	little
May 15, 1908	June 26, July 9, Aug. 6, 26,	156	65	91	140	none
May 28, 1909	July 12, 23, Aug. 6, 27,	243	188	55	29	none
May 9, 1910	July 11, 27, Aug. 15, 23, 30,	240	202	38	18	none
May 15, 1911	July 13, 31, Aug. 12, 24,	156	75	81	108	none
Average for 21 years,		263	159	104	65	

Particular attention is to be called in the table on the opposite page to the results attained during the past four years *during which time there has been absolutely no blight;* but *the sprayed potatoes yielded an average of 66 bushels per acre, or 50 percent more than did the unsprayed.* Applying bordeaux mixture in these years might well be termed "spraying for drought."

Query: If in years when no blight occurs a crop is increased one-half, at a cost of, perhaps, one twenty-fourth; if in years when blight occurs, a crop is increased 27 to 215 percent at a relatively small outlay; why do not more potato growers spray? "If to do were as easy as to know what were good to do, chapels had been churches and poor men's cottages princes' palaces."—*Merchant of Venice I, 2.*